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AUTHOR Sparkes, John J.
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ABSTRACT

This paper offers pragmatic guidance for designing effective distance education courses, including the need for designers to be aware of their educational aims, and the selection of different media and methods for effective learning. Discussion of a brief taxonomy of types of learning--knowledge, skills, understanding, and attitudes--is followed by descriptions of corresponding educational strategies. Steps in the design of a course are also discussed, including: (1) establishing the type of course being offered (i.e., to what extent it involves students acquiring factual knowledge, concepts and understanding, intellectual skills, manual skills, values, and attitudes); (2) establishing students' prior understanding and skills; (3) choosing an educational style to match the subject matter and type of course (e.g., open learning, didactic, multimedia, practical); and (4) matching the communication media to be used (e.g., print, video, audio, audio-vision, telephone conferencing, computer assisted learning, practical kits, and face-to-face tutorials, including tutored video instruction (TVI). Other criteria to be considered would include selecting appropriate media for courses that involve multiple educational aims, matching subject matter to the individual needs of different students, and the cost-effectiveness of each course in terms of materials and labor costs. A rank ordering of the importance of various teaching elements by Open University (UK) students and estimates of teacher time per student-hour of work are presented in tables. (DJR)

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On the Design of Effective Distance Teaching Courses

by

John J. Sparkes

The Open University

Milton Keynes

England

MK7 6AA

IR012330

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Introduction

A well-known aphorism about well structured lectures advises lecturers to "tell'em what you're going to tell'em, tell'em and then tell'em what you've told them". In this presentation, which is intended to be more than a lecture, my main theme is to consider what comparable guidance can be given to distance course designers and teachers. The main question that I shall consider is this. "What principles should guide one in the choice of different media and methods in distance teaching in order to compensate as effectively as possible for the limitations upon face-to-face contact between students and between students and tutors?" Although face-to-face methods are by no means always satisfactory for students - even small group methods can be ineffective - they have the flexibility and the potential to be very good with full time students. Distance teaching is less flexible, and so must be better planned, but it too has the potential to be very effective. But there is much more to attend to if distance students are to learn effectively.

Distance teaching materials and methods have to be well-structured in similar ways to tutorials and lectures, especially so since they carry a heavier teaching burden than lectures. But, in addition, at least the following factors have to be attended to if teaching at a distance is to succeed. These include :

(i) An effective use of distance teaching media and methods

(ii) Provision for personal contact - even though only occasional - between students and tutors or other representatives of the teaching institution.

(iii) appropriate recognition of success, either by the educational establishment through assignment marks and exam results and qualification, or by the students' employers.

(iv) A satisfactory system for judging students' prior experience and education, and of giving credit exemptions, so that students' entry standards will match course expectations.

(v) Reliable delivery systems and effective student guidance and services in case of trouble or complaint.

(vi) Rapid response times to student applications

(vii) A reasonable course fee structure, and a fair system of grants for deserving students.

(viii) A satisfactory working environment and pay structure for teachers, tutors and their support staff. Distance teaching is much more demanding upon teachers (as it is upon students), yet it may not at present count much towards their career development in the profession of higher education.

Education is a complex business so that failure to take due account of each of these factors may not be fatal, but can reduce the effectiveness of the actual teaching and learning that was intended.

In this presentation however I am only concerned with the first of these factors; the principles behind the effective deployment of distance teaching media and methods. The other topics listed are no less important but are not the subject of this presentation.

Although much has been written (1) on the subject of distance teaching media, each method is usually approached from the point of view of its particular features and possibilities, with little attempt being made at comparative assessments. Interactive video, direct satellite broadcasting and expert systems are the latest to promise much. We now know that some of the educational panaceas of the past such as programmed learning, language laboratories, broadcast TV, have their limitations although they have their part to play in education. The list of possible distance teaching methods is being continually extended and is already well past the point at which it is necessary to develop a general pedagogic basis against which individual methods can be judged. It is just such a basis that this presentation attempts to offer. The theory offered is a pragmatic one based mainly on experience, tempered by research results whenever they can be applied, and on many discussions in course teams and elsewhere with colleagues and students.

The experience on which the presentation is based includes over 10 years in industry and elsewhere discovering the needs for continuing education, plus 25 years in school teaching, college lecturing, and universities including 15 years in the Open University in Britain.

The Open University is rich in evaluation data stating which courses are good or bad or interesting and which teaching components are favoured by students. But the data seldom reveal what it was that made them good or bad, so are difficult to use in the course design process.

In this presentation I have attempted to distil from experience some principles upon which to judge the appropriateness of different media for different educational purposes. I also include some comments on student preferences and on costs since these too cannot be ignored in the design of effective courses.

The structure of this presentation

One of the corner stones of the theme I shall be developing is that course designers must be aware of the educational aims that each part of their course is trying to achieve, and to use an appropriate teaching method. This is no less true of lectures or of presentations such as this. So in the conference presentation I shall try to use different presentation methods appropriately to illustrate this basic idea. In particular I shall use a method akin to tutored video instruction (TVI) to present the analysis of types of learning and associated educational strategies that lies at the core of this paper. In this printed version I can only refer to the presentation method without actually using it.

A brief taxonomy of types of learning

With the aim of distinguishing between the different possible teaching methods, the most straight forward taxonomy of types of learning seems to be the most helpful. Although it is possible to subdivide each of the following four classes of learning, along the lines of taxonomies such as Bloom's (2), and although the boundaries between the classes are not always clear cut, it is essential to distinguish between :

1. Learning (factual) knowledge
2. Learning mental or physical skills
3. Learning understanding or comprehension
4. Learning attitudes and values

Of course there are many other ways of dividing up the field of education for different purposes, and it can certainly be argued that, for example the mental skills of analysis or creative design have little in common with the physical skills of typing or playing tennis. But, from a teaching and learning point of view, the strategy to be adopted in each case is essentially the same, and is quite different from that which is appropriate to the other three categories. These four categories seem therefore to be an irreducible minimum from an educational point of view. They might be thought of as analogous to the 3 primary colours to which the infinite variety of perceived colours can be reduced (for example for the design of a colour television sets). In that case too there are no clear-cut boundaries between the categories though the distinctions are nevertheless essential.

It seems that although these categories are generally well understood they can cause difficulties in practice, so I will spend some time clarifying them.

Factual knowledge - is the kind of knowledge that wins "Brain of Britain" or "Mastermind" competitions. The main

point to be made about it is that the learner must be able to understand the meaning of the words, or visual images, that are to be remembered. A parrot like repetition of words does not reveal knowledge. The words or other symbols must be used appropriately. So some prior understanding is necessary before such knowledge can be acquired. I shall refer to this category simply as "knowledge" since it refers to more than just facts. The test of knowledge is the ability to simply recall the answer to a question.

Skills are the ability to do things, so the test of a skill is particularly straightforward. Mental skills are, of course, those performed primarily by the brain, such as speaking, recognising speech, reading, doing mathematics, being creative, being analytical or rational etc. Physical skills such as walking, driving a car, typing, playing the piano, etc also use the brain but somehow seem to do so rather less than mental skills. At any rate the manifestation of them is more physical. We can seldom explain how we can perform any of the skills we possess, we can only demonstrate that we can. The kind of memory appropriate to the recall of knowledge is quite different from that which retains acquired skills. Knowledge can be acquired instantaneously, skills always take time.

The category I have called " understanding" is also sometimes called "deep knowledge" or "comprehension". It is learnt at a deeper level than knowledge; it cannot simply be learnt by heart. It takes time and effort to acquire. You can demonstrate that you can understand concepts by being able to explain new phenomena, or events, or analyse new situations, or design new artefacts, or tackle new problems successfully etc. If the element of new-ness is not present, prior knowledge or previously acquired skills may be sufficient to bring success despite a lack of understanding. For this reason examinations are an unsatisfactory test of understanding - although their primary purpose in higher education is to test for it. Recall can all too easily take the place of understanding. Project work is much to be preferred, except that there are no right or wrong answers!

It is because there are these striking differences between the nature of knowledge and understanding that I have chosen to give them their usual, common sense names rather than use the more academic terms "surface knowledge" and "deep knowledge". The differences between knowledge and understanding are seen to be even more marked when we come to consider how they are best taught or learnt. It is therefore a matter of some surprise that in many taxonomies "understanding" is not regarded as a separate category in the cognitive domain. It is covered by various subclasses of knowledge or skills. The term "understanding" is however used to explain these sub-classes (2,4,5)!

All the same the boundary between knowing and understanding

is not a precise one, they overlap or shade into one another, as colours do. But this does not invalidate the great differences between them. For example "knowing what someone said" does not usually imply a verbatim recall, it implies a recall of what he meant. That is, the words are interpreted through at least a first level of understanding before they are memorised. It is in considering their implications, or the reasons behind their being uttered, that the domain of understanding begins to be entered.

Understanding takes different forms in different subjects. In science most explanations are either applications of generalisations (e.g. Boyle's Law, gravitation, etc) or else are causal in character (The Kinetic Theory of Gases explains Boyle's Law). Historical explanations are extrapolations from past events or generalisations about them. Sociological or political explanations are usually teleological, but may well be presented as causal! Nevertheless, it seems that in all cases, being able to explain depends upon having grasped new, often abstract, concepts and seeing how they entail different phenomena in different circumstances and how they relate to other concepts. It is this as much as anything else that demands special teaching strategies. A term that I might therefore have used is "concept learning" (instead of learning to understand), but this term is already used in the field of education to refer to the discovery of generalisations from sets of data(3) (i.e. to replace the usual term "induction").

The final category of learning, namely attitudes and values, refers to qualities such as motivation, enthusiasm, tolerance, diligence, honesty, reliability, the appreciation of truth, beauty, friendship etc. They are learnt at a deeper level even than understanding and indeed provide the background against which other learning can take place. It seems they are learnt mostly by example from others, and acquired through group discussions or through other social pressures. There are no clear cut tests for them, and are only revealed by the various aspects of each person's behaviour and demeanour.

Corresponding Educational Strategies

The strategies appropriate to the teaching and learning of skills and of knowledge are straightforward enough, but attitudes and understanding require much more time and care. Indeed it is by no means clear that attitudes can be taught or learned in the same sense as the other factors. It is however clear that without appropriate attitudes and motivation little can be achieved in the learning in the other three domains. So I will begin by assuming that we are dealing with suitably motivated students. This is often more true these days of adult students than it is of school leavers.

Learning (factual) knowledge ideally simply requires a clear presentation by the teachers, whether in written, pictorial, diagramatic or spoken form. Given sufficient prior understanding, motivation and a good memory, students can be merely passive absorbers of knowledge. In practise a number of techniques are known to be helpful (4) (e.g. the stressing of interrelationships, learning through frequent short periods rather than a few long ones; not presenting unrelated details, or introducing new topics, or teaching similar topics simultaneously). Students can also learn the skill of structuring knowledge in ways that suit themselves (6). Also it may well be necessary to help with motivation by relating the topics to matters of interest, though individuals differ markedly in this respect, so general rules may not apply.

The learning of skills consists of two parts, one part comprises instruction and demonstration, whilst the other consists of plenty of practice - preferably supervised. Feedback from a tutor is important in the early phases of skills-learning but is not so crucial once students have acquired their own internal reference mechanisms. Most mental skills, like knowledge, build on prior knowledge and understanding, so there is a limit to what can be achieved in any one training course. Figure 1 indicates the relationships involved. In particular it indicates that learning relevant knowledge and skills forms a part of learning understanding, so the learning processes form an iterative sequence. You cannot get very far in one domain without advance in another.

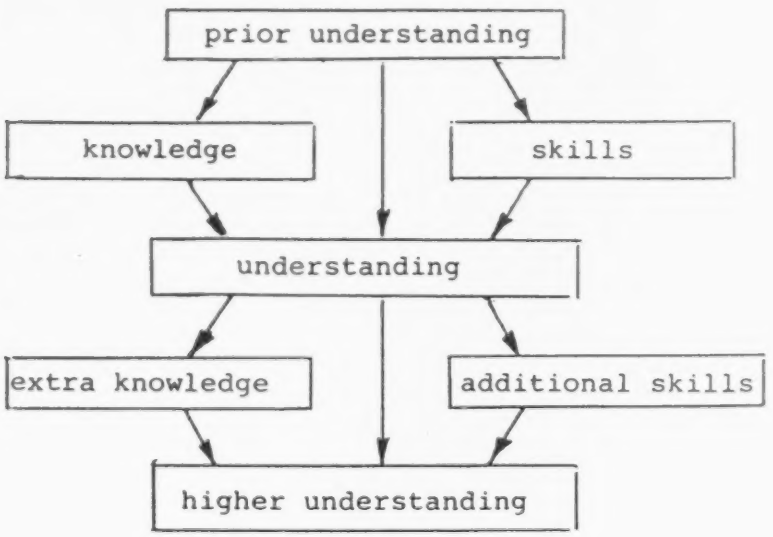

Figure 1 A diagram illustrating that advances in knowledge, skills and understanding depend primarily on previous understanding, but also on prior knowledge and skills

To acquire understanding effectively it seems that the secret is to be immersed in a rich educational environment. The concepts, many of which are abstract, upon which understanding and problem solving usally depend, have to be planted and nurtured in students' minds. The way to do this is not simply to define them but also to illuminate them from different directions, so that they gradually take shape and gain substance and eventually become as real to the students as the everyday objects around them. This means that these concepts must be put in context, analysed, discussed, applied, read about in text books, exercised in problems, mulled over and so on. At conventional universities lectures introduce the concepts but do not teach much; learning takes place in tutorials, seminars, libraries, laboratories, essay writing, using computers, arguments in the coffee bar, rewriting notes etc. In distance teaching universities, such as the Open University, the printed texts both set the syllabus and begin the teaching process, but they are supported by TV or video tapes, audio-tapes and audio-vision, tutorials, self-help groups, assignments and correspondence tuition, summer schools, telephone contact, home experimental kits, counselling etc. So a rich educational environment is created with only a minimum of face-to-face contact.

More recently, tutored video insruction (TVI) has been found to be very effective as a means of teaching conceptually difficult subjects - from electronics to poetry. It is a method which enables small group teaching - which, when properly handled, is one of the most effective methods of acquiring understanding - to achieve maximum effectiveness. The tutor does not have to be a subject expert, only a little more advanced than the students. His role is to encourage debate and discussion of each short section of a video recording of a lecture by an expert. The lecture becomes a learning resource rather than an ephemeral event. Thus it converts the lecture, which is not an effective teaching method, into an excellent learning forum.

TVI is somewhat restricted in the range of types of teaching it can handle. It is not especially effective as a means of teaching factual knowledge (as distinct from understanding), or as a method of skills-training, since the main learning activity is the discussion of ideas. But for developing comprehension or understanding it is an almost ideal method, provided small group teaching is a practical possibility. It is finding much success as a means of providing continuing education in industry (7) and can be used as a form of tutorial in conventional universities. It can only be used with home-based students when groups can be drawn together to form tutorials.

An alternative method is tutored audio-vision instruction (TAVI) in which an audio-tape plus printed diagrams replaces the video tape. Both methods depend for their success upon

the provision of a common educational experience for the group to discuss. Prior reading or homework is never as effective.

The learning environment in which students can acquire understanding not only needs to be rich in the variety or flexibility of the learning opportunities it provides, it should also be structured to develop the (abstract) concepts upon which most understanding is based. It has been shown that scientific learning is much improved if students can be given the opportunity to discover laws, concepts and theories, rather than be taught then. However this is a very time consuming technique and can lead to the wrong theories being discovered. Also the improvement in learning may well be a motivational effect, rather than a cognitive one, so that it might be capable of being tackled in other ways such as group discussions. But in science and technology it is important to bear in mind in that experimental kits should be capable of more than wholly prescribed tasks.

Three further points about concept learning need to be stressed. Firstly, since concepts are normally abstract (e.g. energy in physics, status in sociology, profit and loss in economics etc) they cannot be photographed or video taped as can real objects. They have to be expressed in words, or in other symbols (such as mathematical ones) which in turn have to be explained in words. Explanations of concepts can however be supported visually by analogies and animation, by showing the context in which the concepts are important, and by observing demonstrations of design or analytical skills in which the concepts are used. But words must be allowed to dominate. The pictorial images of television or video tapes must support the spoken word rather than vice versa. (This contrasts with the use of television for conveying knowledge, such as natural history, or for demonstrating practical skills, where spoken words support the pictures).

The second point has already been referred to, but needs stressing, that small groups of students provide a very effective forum for this category of learning (5). To quote Abercrombie (p8) "The great advantage of group work is in facilitating the understanding, as distinct from the more acceptance, of information - in helping the student to comprehend it, grasp it, make it his own".

In distance teaching small groups may be difficult to assemble, so that when they are, they should be used to maximum effect. That is, to help with the development of understanding through discussion, a task for which TVI appears to be almost ideal, since the local tutor does not have to be the expert. Indeed tutorials should be used specifically to strengthen those parts of the course that are conceptually the most difficult.

It is, possible to use telephone conferencing to create small group discussions, and to add video-tape transmissions, interrupted and replayed as required, and so set up "distance TVI". (Note that this is not the same as a TV broadcast of lécture with two-way audio communication to allow questions of the lecturer.)

The third factor of importance in designing courses that teach understanding is to arrange that difficult concepts are dealt with in a variety of ways. It is tempting to allocate different parts of a course to appropriate media (moving pictures to TV, calculations to print, opinions to audio tape etc) and to ensure that there is no duplication. This strategy is correct for teaching knowledge, but is not correct for teaching understanding. For this purpose the particular strengths of different media should be deployed to illuminate the same difficult concepts.

As regards the teaching of attitudes and values there is evidence that small group discussions have an important influence (5). It is also true that television in particular can affect the emotions and so influence attitudes and values. But the effects are by no means predictable. So much less can be said about this learning domain than about the others.

Summary

To teach knowledge : provide well structured material by the most appropriate method.

To teach skills : provide instruction and demonstration (preferably by video tape) followed by oportunities for practice.

To teach understanding : provide a rich educational environment. Focus teaching components on relevant concepts, skills and knowledge. Use remote small group tutoring, especially TVI or TAVI, whenever possible.

To teach attitudes : Use remote small group tutoring whenever possible. Also well produced TV.

Different kinds of courses

Actual courses normally involve more than one kind of learning so appropriate media need to be combined to achieve the required multiple educational aims. The following types of courses are worth distinguishing.

Degree courses and upgrading courses are mostly concerned with teaching understanding. This normally also involves

teaching specialised knowledge and skills since these not only help with learning understanding but they are also to be expected of graduates and professional people. Degree courses and upgrading courses differ in the amount of prior understanding to be expected of their students. Degree courses build on school leaving standards whereas upgrading courses normally build on first degree standards they are intended to take graduates further into their choosen field of expertise.

Updating courses however are not primarily concerned with teaching understanding, they are intended to increase students knowledge within their previously acquired level of specialist understanding. General interest courses are similar except that the level of prior understanding is general rather than specialised. Awareness courses are also similar except that they are designed for professional people who have some field of specialism. Such courses are intended to bring them up to date in topics outside their profesional field, so these courses may have to teach understanding at a superficial level as well as the appropriate knowledge.

Training courses are primarily concerned with teaching skills of one kind or another.

Evidently then the kinds of provision needed for these different kinds of course are very different. In over-simplified terms they amount to this:

For degree courses, upgrading and to some extent awareness courses, a rich educational environment is required, possibly involving printed texts, video, audio vision, home kits, tutorials etc. Usually choices have to be made for economic reasons as discussed in the next section.

For updating courses and general interest courses a single appropriate form of communication is usually enough. Even just providing facts or data may be all that students require.

For training courses demonstration and instruction plus opportunities for practice are needed. However, in distance teaching, opportunities for appropriate practice are sometimes difficult to provide.

The Problem of Cost-Effectiveness

The design of effective courses by a a particular institution in a particular country depends greatly on local conditions, on the money supply, on the availability of suitable teachers, on the numbers of students, on the production methods used for course materials, distribution methods etc, so no general rules can be laid down.

Inevitably however the question of the effectiveness of a course soon turns into one of cost-effectiveness and choices have to be made as to where its best to spend money.

Within the Open University system a clear rank ordering by the students of different kinds of teaching methods was obtained in a survey carried out by Swift and Kelly (8) as follows:

Students were asked to rank-order the relative importance of the different components of their particular courses. The results are shown in Table 1. The percentage of students giving Rank 1 are in column 1; those ranking each component in Ranks 1 through 4 are given in column 2.

The great importance attached to printed units and supplementaries is primarily a reflection of the central role taken by printed units in most Open University courses. Column 2 is more significant since it picks out the next three course elements.

Table 1: Rank ordering of teaching elements

Component	Rank 1 (%)	Ranks 1 - 4 (%)
Printed units and supplementaries	81	96
Assignments (TMA, CMAs)	5	80
Set books	6	67
Summer Schools	10	62
Correspondence teaching	4	62
Other tutor contacts (mainly face-to-face)	4	33
TV/video plus notes	1	30
Radio plus notes	1	24

(Note: components not included in the survey, because relatively few courses make use of them are (i) audio-vision - used in mathematics, technology and science with great success, (ii) practical home kits - used successfully in electronics but less so in other subjects)

The survey also showed that 39% of students would have liked more tutor contact (i.e. TMA marking, correspondence teaching, face-to-face tutorials etc). This is similiar to the estimatd percentage (no precise data given) of those who attended face-to-face tutorials. The tutorial provision amounts to an average of about 14 hrs per half-credit course, though it varied a good deal. In other words about 60% of students did not want more tutorial support. This is particularly surprising since, in general, face-to-face teaching is both popular and effective. The reasons certainly include the problems of travel to a study centre and of sparing the time. But it is possible, following the

above analysis, that the tutorials sessions were not used as well as they might be.

In another study by Murgatroyd (9) it becomes clear that although the tutorials are intended to be remedial they often become, at students'request, chalk-and-talk classes. Tutors' attempts at generating interaction are not on the whole very successful. This contrasts markedly with TVI, or possibly tutored audio-vision sessions, in which short sections of the tape (either video or audio) provide a sequence of immediate, authoritative common experiences for students to discuss with the tutor or amongst themselves. This use of face-to-face tutorials fits in well with the strategy outlined earlier for helping with difficult concepts.

It should be noted that the survey data refer to a number of different courses and to different kinds of students. The data for science courses are not the same as for history or philosophy or economics. Equally different students have different styles of study and learning. Clearly the components of a course should include those that are matched to its subject matter (e.g. electronic apparatus for electronics courses, colour printing and TV for art history, face-to-face tutorials for philosophy), but also attention should be paid to the differing needs of different students. Ideally, costly course components should only be provided for those who want them, but this kind of selectivity is very difficult to achieve. It remains true that acquiring understanding in complex subjects demands a variety of approaches, as explained earlier, but the optimum mix is not the same for all students. So when it is not economically possible to provide a wide enough variety to allow students to make their own choices, the most generally effective ones have to be chosen.

The costs of different teaching methods and media differ very widely. Some of the costs are labour costs arising from the time spent by teachers and their support staff, some are production and distribtuion costs, such as printing, broadcasting, tape copying etc, and some are overheads. The last two kinds of costs depend very much on the overall educational system in use, and cannot be generalised. However the costs of the teaching staff are relatively constant so the staff-time involved in each teaching method provides a useful means of comparison between different methods.

The parameter I shall use is the teacher-time needed to prepare one hours-worth of student work. Then the greater the number of students served by this amount of teaching effort the smaller the cost per student. For example, if it takes 50 hrs of professional time - teacher plus producer- to produce a 30 minute video-tape this is equivalent to 100 teacher hours per student-hour of work. Support staff in a TV production centre might more than dobule this - say, 300

hrs per student hour. If a total of 1000 students view the programme the cost per student is 0.3 staff-hours per student-hour. This can be compared with a classroom teacher who has a class of 25 students and spends an hour preparing each lesson. So the cost (in teacher time) is 2/25 = 0.08 teacher hours per student. So face-to-face teaching is cheaper until the TV student audience exceeds 2500. Table 2 shows some estimates of teacher time per student-hour of work and shows the heavy demands on staff time that some methods make.

Table 2 Teacher-hours per student hour

Teaching method	Ratio of academic man-hours per student-hour of work generated
Lecturing	2 - 10
Small group teaching	1 - 10
Teaching by telephone	2 - 10
Video-tape lectures (for TVI)	3 - 20*
Audio-vision	10 - 20*
Teaching text	50 - 100**
Broadcast TV	100 or more**
Computer-aided learning	200 or more*
Interactive video disc	300 or more**

* requires support staff
** requires several support staff

Into the equation must also be put an assessment of the educational value of each activity, and this is a function of the educational aim, as already explained.

Conclusion

The final step in the overall course design process is to decide on the media and methods to be used to achieve the agreed aims at an acceptable cost. This of course involves an appreciation of the educational effectiveness of each possible medium as regards each kind of aim, but is beyond the scope of this presentation. I have made limited comments on a small number of possible media; the complete assessment of all available media is an immense task and is scarcely possible in an objective way.

For example, recently a good deal of work has been done in assessing the possible uses of computers in education. The following is a representative list.

1. Teaching about computers
2. Using applications packages

3. Continuous assessment
4. Electronic blackboard systems (e.g. Cyclops)
5. Database access
6. Electronic mail and software
7. Tutorial computer assisted learning
8. Problem solving monitoring.
9. Drill and practice
10. Simulation
11. Modelling
12. learning management
13. Games
14. Computer conferencing

Such a list is however only the starting point. Each item must next be set against alternative ways of achieving the same function and then a judgement must be made as to which is likely to be the most cost-effective, taking into account all the factors referred to earlier.

This presentation has stopped short of this final stage and has concentrated mainly on the educational principles behind such a detailed assessment.

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